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Application of the linear principle for the strongly-correlated variables: Calculations of differences between spectra

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ABSTRACT

In this paper the authors suggest a new method of detection of possible differences between similar near infrared (NIR) spectra based on the self-similar (fractal) property. This property is a general characteristic that belongs to a wide class of the strongly-correlated systems. As an example we take a set of NIR spectra measured for three systems: (1) glassy carbon (GC) electrodes, (2) GC electrodes affected by azobenzene (AB) substance and finally (3) films (AB-FILM). Besides the physical model that should describe the intrinsic properties of these substances we found the fitting function that follow from the linear principle for the strongly-correlated variables. This function expressed in the form of linear combination of 4 power-law functions describes with the high accuracy the integrated curves that were obtained from the averaged values of the initially measured spectra. The nine fitting parameters can be considered as the quantitative "finger prints" for detection of the differences between similar spectra. Besides this result we established the *self-similar behavior* of the remnant functions. In other words, the difference between the initially integrated function and its fitting function can be expressed in the form of linear combinations of periodical functions having a set of frequencies following to relationship $\omega(k) = \omega_0\xi^k$, where the initial frequency ω_0 and scaling factor ξ are determined by the eigen-coordinates method. This behavior in the NIR spectra was discovered in the first time and physical reasons of such behavior merit an additional research.

1. Introduction

In many applications which appear in the area of science and engineering we deal with similar and close measured data. From the signal analysis point of view one of the important problems is to read these data and to get the required information from them. At the first side this issue seems trivial but in the case of complex systems the recorded signals are very different to analyze (for more information see [1]). Namely, the existing methods as the wavelet method, Fourier transform or their newly fractional generalizations depend on some assumptions which depend on the specified problems [2–4]. In

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